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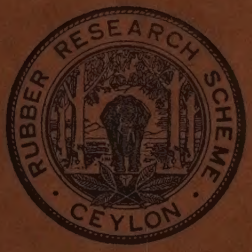

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PARANITROPHENOL IN CREPE MANUFACTURE

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THE use of Paranitrophenol (P.N.P.) as a preventive of infection in crepe rubber was first suggested by Edwardes, Rubber Growers' Association Chemist in Malaya, in 1925. Later experiments in Ceylon confirmed that the development of mould and fungal spots in crepe during drying and storage could be prevented by the presence of a small proportion of the chemical in the rubber. It was shown that soaking the wet crepe in a solution of P.N.P. led to discoloration of the finished product but that the appearance was unaffected if a suitable proportion of the chemical was added to the latex with the coagulant. The quantity required under ordinary conditions of manufacture and storage amounted to 1 part of P.N.P. to 4,000 parts dry rubber. A series of vulcanization tests carried out by the London Staff of the Research Scheme showed that the quality of the rubber was not affected by the presence of the chemical, and its use was subsequently recommended in Ceylon as a means of preventing the development of infection in crepe during drying. The treatment was adopted on a few local estates and proved very satisfactory.

Objection to the presence of P.N.P. in crepe rubber has recently been raised by manufacturers on the grounds that it is liable to cause staining of certain coloured goods and of the wrapping papers used for packing. A memorandum on the subject from an Association representing manufacturing interests included the following paragraph "The Committee were strongly of the opinion that although the moderate use of this mould preventative had been shown to be beneficial in the preparation of smoked sheet, it was very undesirable that excessive or uncontrolled amounts should be used in the preparation of rubber which might be used for the manufacture of coloured goods." Commenting on the memorandum the present writer expressed the view that the use of excessive quantities of the chemical on

estates was very unlikely and if there were difficulties in manufacture that they were probably attributable to the very small proportion of P.N.P. which was normally used as a mould preventive on certain estates. A commercial sample of crepe containing the specified amount of P.N.P. was submitted for trial and tests by two manufacturers have shown that staining of wrappings is liable to occur. No staining of the rubber articles was reported but it was stated that a coloured extract could always be obtained from them by soaking in water.

Although a relatively small proportion of the total output of crepe rubber is used for purposes in which this difficulty is likely to be of importance, it is necessary for Producers to meet the wishes of Consumers in every way possible and the Rubber Research Scheme cannot, therefore, recommend the further use of P.N.P. in crepe manufacture. It is unfortunate that this decision is necessary as P.N.P. is the only chemical tested up to the present which is suitable in other ways for preventing the development of mould in crepe during drying. Under present circumstances the only advice which can be given for preventing this increasingly common defect is to improve the efficiency of drying rooms by the provision of warm air installations.

It should be made clear that no objection has been raised to the use of P.N.P. as a mould preventive in smoked sheet; in fact its moderate use for this purpose has been endorsed by manufacturing interests as indicated in a preceding paragraph.

CEYLON CLONES—II

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FOREWORD

THIS article, presenting data for 1933, is the second of a series of annual reports on Ceylon clones, the first of which was published in Rubber Research Scheme *Quarterly Circular* Vol. 10, Part 2, 1933.

At the end of 1933 yield records were being received at these laboratories from 70 Ceylon clones established either on estates or at the Rubber Research Scheme Experiment Station, Nivitigalakele. Many of these clones, however, were only brought into tapping towards the end of the year, and although some of the records show promise they are hardly of sufficient duration to be included in this report. The number of Ceylon clones, therefore, of which the data are sufficiently extensive and promising to merit publication remains small, and, in fact, only two new clones have been added to the 1932 list.

Acknowledgment is here made to the undermentioned proprietors who have kindly given permission for the publication of the records of clones established from mother-trees on their properties:

The Govina Rubber Company, Ltd.
The Lavant Rubber Company, Ltd.
The Mirishena (Kalutara) Rubber Company, Ltd.
The Dimbula Valley (Ceylon) Tea Company, Ltd.
Mr. C. E. A. Dias.

PRESENTATION OF RESULTS

The records for 1933 are given in Tables I-VII. Except for the Milleniya and Wawulugala clones records are available from each individual tree, and the average yield in grams of dry rubber per tapping is given for each tree and for the clone average for each month and for the whole year. The total yield for the year is also expressed in lb, and this figure should be considered in relation to the number of tappings recorded. The tables also contain measurements of girth, and of primary and renewing bark.

Notes on rate and habit of growth, disease incidence, colour and quality of rubber, etc , were given in last year's report, and these are supplemented by any further observations made during 1933.

CLONES AT EXPERIMENT STATION NIVITIGALAKELE

GENERAL NOTES

A brief history of the 1926 Clearing was given in last year's report. The 1927 Clearing, in which Clone Eladuwa I (abbreviated to ELAD.I) is established, was planted with basket plants in October 1927, most of the trees in this clone being budded in 1928-29.

For these preliminary records the policy being adopted at the Station is to bring trees into tapping, up to 12 of each clone, as soon as their girth exceeds 16 inches. Indications of potential yield are thus obtained at as early an age as possible, but since trees are clearly selected on vigour the average yield is not representative of the whole clone. More permanent records of greater value will be derived from further groups of trees opened when all trees of the clone are of a suitable size for commercial tapping. Some of the older clones will be tapped in this way in 1934.

At the end of 1933, 33 Ceylon and 2 imported clones, represented altogether by 283 trees, were being test-tapped on the Station. Only three of these clones are mentioned in this report, and these can be considered of no more than moderate promise. The fact that no outstanding clones have yet been disclosed at Nivitigalakele is disappointing, but better results are anticipated from the later mother-tree selections established in the 1928 Clearings.

Tapping.—Tapping has continued to be on alternate days on a half spiral cut at an angle of 25°. The 1932 panels were not changed over, and all new trees were opened at a height of 48 ins. from the union. Bark consumption is carefully regulated at $\frac{1}{2}$ in. per month.

The trees tapped during 1932 were given a generous rest over the wintering period in February and March 1933. Additional trees were taken into tapping in April in order to bring the number in each clone up to 12.

Tapping conditions were very bad during most months, rain interfering with the work to an abnormal extent. The tables show that there were only 108 tappings during the 10 tapping

months. The trees were tapped on about 10 additional occasions on which the latex could not be collected, and this interference by rain accounts for the varying number of recorded tappings for the individual trees of each clone. On many days the trees could only be tapped late in the morning or early in the afternoon.

Recording.—The methods for collecting the rubber and recording the yields have remained the same as for 1932, and are described in last year's report.

NOTES ON INDIVIDUAL CLONES

Clone G. 771.—Reference to Table I will show that seven trees were tapped in 1932, being rested during February and March 1933, while a further five trees were taken into tapping in April. The average yield per tapping for the clone for 1933 was 16·2 grams. This represents a disappointing increase on the 1932 figure of 13·1 grams, but the inclusion of the five new trees, and the unfavourable tapping conditions, must be taken into consideration. On the basis of the yield figures the clone is of fair promise, but it possesses various defects which render its economic value doubtful.

The latex is exceptionally thick and coagulates very early on the cut and in the cup. This is accompanied by a tendency to late flowing, with the result that there is a large proportion of scrap. Considerable difficulty would probably be experienced with manufacture unless an anti-coagulant were used in the field.

This clone suffered severely from wind damage during heavy storms experienced in May, the injury chiefly taking the form of breakages at the junction of lateral branches.

The figures given in Table I show that primary bark is somewhat thin, but that renewal is very good.

Clone LAV. 28.—As shown in Table II four trees were tapped in 1932, being rested in February and March 1933, while a further eight trees were taken into tapping in April. The average yield for the year is 10·6 grams per tapping which, again, is a poor advance on the 1932 figure. Owing to the fact that there is only a small number of original 1927 buddings the age of the trees in tapping is somewhat varied, and this complicates a comparison with other clones. The clone cannot be considered very promising and will be omitted from future reports unless a substantial improvement occurs.

No defects have been noted. Growth is vigorous, and the crown, although large, does not appear to be unduly susceptible to any form of wind damage.

Clone ELAD. 1.—This clone occurs in the 1927 clearing, the trees in tapping being, on an average, a year younger than those of the clones mentioned above. They were tapped for the first time in April 1933. The average yield for the year, 9·2 grams per tapping, is not outstandingly high, but with the exception of December, when an unaccountable fall occurred, there has been a steady increase throughout the year.

Growth is very vigorous, and primary and renewing bark are satisfactory. There have been no cases of disease or wind damage.

HILLCROFT CLONES

GENERAL NOTES

We are again indebted to Mr. L. P. Gapp for close co-operation in the test-tapping of the Hillcroft clones on Stennes Estate. In last year's report particulars were given of two clones, HC. 28 and 34, and to these are now added HC. 55 which was first tapped in March 1933.

Tapping.—As at Nivitigalakele, tapping is on a half spiral cut on alternate days. The cuts were originally opened at a height of 48 ins. from the union, and as the panels have not been changed the cuts on Clones 28 and 34 were at a height of about 38 ins. at the end of the year. Bark consumption is at the rate of $\frac{1}{2}$ in. per month.

As shown in Tables IV and V the trees of Clones 28 and 34 were rested during February and March.

As at Nivitigalakele, rain interfered greatly with tapping during a large part of the year. This is illustrated by the fact that only 100 tappings could be recorded for the 10 tapping months (although the trees were actually tapped on 109 occasions), and that 40 of these tappings started late, *i.e.* at times varying from 7 a.m. to 2 p.m.

Recording.—The methods have remained the same as in 1932. The latex from each tree is measured and coagulated in the cup, and the biscuits are sent every month to the laboratories to be dried and weighed. Unlike the procedure at Nivitigalakele and Wawulugala, scrap rubber is not included.

Quality of Rubber.—Samples of smoked sheet and blanket crepe from Clones 28 and 34 were sent to London for examination at the end of 1932. The rubber from HC.28 was found to be unusually soft whether prepared in sheet or crepe form, and this characteristic will be of considerable value if retained as the

trees grow older. Tests on tensile strength and ageing properties gave somewhat unsatisfactory results for both clones, but since this is a common feature of rubber from young trees there is no reason to suppose that the rubber will remain abnormal in these respects when the buddings are fully mature. A further series of samples has recently been despatched to London, and the report is awaited with interest.

NOTES ON INDIVIDUAL CLONES

Clone HC. 28.—Reference to Table IV will show that the average yield per tapping for 1933 was 46·7 grams. Taking the unfavourable weather into consideration, this represents a satisfactory increase on the 1932 figure of 41·9 grams. A notable and highly satisfactory feature of this clone is the uniformity amongst the individual trees, the coefficient of variation of yield being as low as 12·8 per cent.

When considering the average yield per tree a point regarding the selection of the individuals for tapping must be borne in mind. When the twelve trees were originally selected for tapping in 1931 most of the other buddings in the clone were not large enough to be tapped. The girth of the test-tapped trees is therefore substantially greater than the average for all trees of the clone. Since in any one clone there is a high degree of correlation between girth and yield it is clear that the records are not fully representative of an average stand. In other words, the total annual yield from an average acre of 96 trees of this age cannot be calculated as eight times the total yield (123·2 lb.) from these 12 trees. The yield must, nevertheless, be considered outstandingly high, and since the clone has developed no serious defects it may now be regarded as of definite economic value.

Reference was made in last year's report to the pronounced spiral fluting of the stem. This characteristic is now developing in 1930 budgrafts at Nivitigalakele which until recently were quite straight. In other respects, however, the growth is entirely satisfactory, and there is no reason to suppose that even in the worst cases will the twist interfere with tapping. A minor defect of this clone is the marked yellowness of the rubber.

The figures in Table IV show the thickness of primary and renewing bark to be satisfactory.

Clone HC. 34.—The average yield for 1933 was 28·6 grams —slightly less than the 1932 figure. Various unsatisfactory features of this clone were mentioned in last year's report, the most important of which being its exceptionally poor growth, and

since the yield has shown no increase the clone is unlikely to be of economic value.

Clone HC. 55.—This clone was budded in the nursery in 1925 and the stumps planted in the field in 1926. Tapping was commenced in March 1933, only two trees being at first opened. A third tree was added in April and the number was brought up to 10 in June. A difference in the method of selecting these trees as compared with Clone 28 is to be noted. The first three trees were selected on pricking tests, but the additional seven trees were chosen entirely at random.

From the commencement of tapping some doubt was cast on the identity of certain individuals owing to the extraordinary variation in yields; this is exemplified by the annual averages which vary from 13·9 to 98·3 grams per tapping. Judged by vegetative characteristics, growth habit etc., all the trees are similar, but tree No. 3, whose yield is phenomenally high for its age, differs in respect of the rate of oxidation of the latex and shape and colour of the seed. The obvious explanation that this tree is a "rogue" does not appear to be correct, and although mutation is not a phenomenon commonly associated with Hevea it would appear that the tree may be a mutant, or "sport". Budwood has been taken from several trees of the clone in order that a critical comparison of the young shoots may be made. In the meantime we can only conclude that Clone HC. 55 displays a high degree of variability in its early yields.

The average yield for the year was 49·1 grams per tapping; this is slightly higher than Clone 28 which is of approximately the same age. Two satisfactory characteristics of the clone, both of which are particularly marked in the case of tree No. 3, are the early cessation of flow despite the high yield, and the small amount of scrap; one day's scrap for tree No. 3 was found to weigh about ·5 gram, the yield for that tapping being nearly 100 grams. As shown in Table VI the rubber content of the latex is low (32·7 per cent.), though this may be expected to increase as the trees mature.

Growth is very vigorous and the stem straight. The primary bark is somewhat thinner than that of Clone 28, but the 8 months' renewal is satisfactory.

Tree No. 10 developed Brown Bast in December, the entire panel from the cut to the ground being affected, and the trees will be carefully watched for any further cases of this disease. No other defects are to be reported.

MILLENIYA AND WAWULUGALA CLONES

GENERAL NOTES

In this section are included clones derived from mother-trees on Milleniya and Wawulugala Estates, and we are again indebted to Mr. C. E. A. Dias for his co-operation. The records given in Table VII are from Wawulugala Estate.

Tapping.—From January to May the trees were tapped every three days on two opposite half spiral cuts, the height of the cuts at the beginning of the year being approximately 34 ins. and 18 ins. from the union respectively. After three months' rest tapping was resumed in September, each cut being tapped singly every four days on alternating dates. Thus the trees were tapped on alternate days, and the system is comparable with alternate day tapping on a single half spiral.

The two tapping systems employed complicate a comparison with the yields of other clones on the basis of the annual average or total, but it is nevertheless clear that Clones W. 259 and W.320, in particular, are of promise.

Recording.—In March, April and May the individual tree biscuits were sent to the laboratories to be weighed; in the remaining months the total rubber for each clone was creped and weighed on the estate. The figures include scrap.

NOTES ON INDIVIDUAL CLONES

Clone M. 191.—The yield of this clone is high, but one of the ten trees in tapping has developed Brown Bast in 1934, and one has suffered from wind damage. Growth is exceptionally vigorous.

Clone W. 120.—The yields have remained at a relatively low level.

Clone W. 259.—This is the most productive of the Wawulugala clones, and the yields during the last few months of the year give excellent promise. A minor defect is a tendency to late dripping.

Growth is vigorous but the stem tends to be slightly fluted. Primary bark is thick and renewal excellent.

Clone W. 320.—The yield has shown a satisfactory increase when the change in tapping system is taken into consideration, and the yield per foot of tapping cut is nearly as high as that for W. 259. The trees, despite being small, give the impression of being robust and well grown, and it is probable that this clone would give good results with relatively close planting. Primary and renewing bark are satisfactory.

TABLE I.

CLONE GOVINNA 771. 1933

Tree No.	When budded	Average yield in grams dry rubber per tapping													Total yield for year 1933 and No. of tappings		Girth at 3 ft. in July 1933		Thickness of bark	
		1932.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1933.				Primary at 3 ft. in Feb. 1934	Renewing 22 months' renewal
		Number of tappings																		
		86	15			13	5	8	12	12	12	7	13	13	86-108	lbs.	tappings	ins.	cms.	mms.	mms.
38	Aug. 1927	12·2	15·1			14·2	15·2	17·7	17·2	19·5	20·2	17·2	20·3	19·9	17·7	4·1	106	22·0	55·9	7·0	7·5
87	May 1927					4·6	3·9	10·8	6·9	9·6	15·0	14·1	18·9	14 7	11·5	2·3	91	19·7	50·0	5·0	*5·0
91	Aug. 1927	12·2	17·3			13·8	14·4	18·9	17·8	17·9	24·3	14·9	30·7	27·6	20·2	4 6	105	24·5	62·2	6·5	7·5
97	May 1927					3·6	5 2	13·1	6·5	7·8	3·2	10·4	17·2	15·4	9·2	1·8	90	18·5	47·0	5·5	*4·5
98	Aug. 1927	14·6	18 2			19·8	15·8	19·9	20·3	20·7	20·8	13·4	24·3	26·2	20·6	4·9	108	25·5	64·8	7·5	7·0
199	Aug. 1927	16·5	19·3			17·8	16·2	23·6	18·6	19·9	23·1	14·2	25·5	25·6	20·8	4·8	105	24·0	61·0	7·5	6 5
203	May 1927					5·4	7·7	12·4	11·0	12·5	14·9	12·0	18·8	23·7	13·5	2·7	90	19·7	50·0	6·5	*5 0
310	Aug. 1927					13·8	11·8	13·4	12·5	13·3	17·7	14·9	12·6	8·9	13·2	2·5	86	23·0	58·4	6·5	*6 0
385	May 1927					10·0	7·6	15·9	11·6	13·8	18·7	17·0	21·7	18·8	15·2	2·9	88	23·7	60 2	6 0	*5·5
386	May 1927	10·6	11·6			14·5	12·5	16·7	13·8	15·2	15·5	10·5	19·5	15·5	14·6	3·5	107	24 0	61·0	8 0	7·0
403	May 1927	13·4	16·1			17·2	14·2	15·8	16·4	18·2	19·5	15·4	19·9	10·2	16·5	3·7	101	20 7	52·6	7 0	7 5
558	Aug. 1927	12·0	15·1			16·5	14 1	20·6	18 1	17·7	17 6	16·3	25 3	19 6	18 2	4·0	99	21·0	53·3	7·0	6·5
Average for clone		13·1	16·1			12·6	11·7	16·5	14·2	15·4	17·5	14·2	21·3	18·9	16 2	3·5	98	22 2	56·4	6·7	6 3

RESTED

Tapping System. Half spiral on alternate days

*10 months' renewal

TABLE II

CLONE LAVANT 28, 1933.

Tree No.	When budded	Average yield in grams dry rubber per tapping													Total yield for year 1933 and No. of tappings		Girth at 3 ft. in July 1933		Thickness of bark	
		1932	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1933				Primary at 3 ft. in Feb. 1934	Renewing 10 months' renewal
		Number of tappings																		
		86	15			13	5	8	12	12	12	7	13	13	88-108	lb.	tappings	ins.	cms.	mms.	mms.
26	Nov. 1927					5·8	5·0	7·6	9·3	10·1	11·2	8·8	15·6	18·4	10·9	2·2	93	24·0	61·0	7·0	6·5
27	,,					4 0	3·7	6·7	6·8	8·6	10 1	6·9	9 6	12·2	8·0	1·6	91	20·5	52·1	6·5	5·5
131	,,	12·6	19·9			13·1	15·0	16 0	15 1	17·2	17 1	17·3	20·8	21·0	17 5	4·2	108	30·2	76·7	9·5	*7 5
132	June 1929					3 3	3·2	7·3	5·3	7·2	7·4	6·6	9·7	10·8	7·0	1·4	91	21·0	53·3	7·0	6·5
134	Nov. 1927					8·0	8·0	12·5	10·1	11·0	13·5	12·6	15·5	18·4	12·4	2·5	93	22·5	57·1	7 5	6 0
260	,,	7·1	8 6			5·8	5·5	8 0	9·2	11·6	13 4	12 6	15·5	16·1	10·9	2·6	107	24·7	62·7	8·0	*8·0
264	,,					5·8	8·5	9 6	12·9	15 1	13 5	11·6	12·6	11 7	11 4	2·2	88	23·0	58·4	7 5	7·0
334	,,					6·6	6·1	8·9	9·4	9·2	10·4	10·7	9·8	10·8	9 2	1·8	91	21·5	54·6	7·5	7 0
339	,,	6·4	10 8			6·1	5·1	8·0	8·0	10·0	9·9	10·5	9·5	11·9	9 2	2·1	103	26·2	66·6	8·0	*7·0
443	Aug. 1928	8·2	11·2			3 8	4 2	7·9	8·8	12 7	10·3	10·6	13·7	15·5	10·3	2·4	105	22·5	57·1	8·0	*5·5
446	June 1929					5·0	7·3	1·9	5·1	6·9	9·1	6·5	10·3	8·6	7·0	1·4	91	19·5	49·5	5·5	5·5
467	,,					3·9	5·5	8·2	8·0	8·8	8·4	6·8	13·3	11·0	8·6	1·7	90	19·5	49·5	6·5	5·0
Average for clone		6·8	12·6			6·0	6 3	8·6	9·0	10·7	11·2	10·1	13·1	13·8	10·6	2·2	96	22·9	58 2	7·4	6 4

RESTED

Tapping System. Half spiral on alternate days.

*22 months' renewal.

TABLE III.

CLONE ELADUWA I. 1933.

Tree No.	When budded	Average yield in grams dry rubber per tapping										Total yield for year 1933	Girth at 3 ft. in July 1933		Thickness of bark	
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec	1933				Primary at 3 ft. in Feb. 1934	Renewing in 10 months' renewal
		Number of tapping														
		10	5	6	12	11	11	8	12	14	84-90	lbs.	ins.	cms.	mms.	mms.
677	Dec. 1928	2·6	3·1	6·2	5·7	7·6	8·9	6·0	15·0	7·0	7·4	1·4	19·7	50·2	5·5	5·5
855	,,	4·1	6·2	10·9	11·0	12·4	17·6	12·1	17·0	9·4	11·6	2·2	20·7	52·6	7·0	5·5
856	,,	4·4	5·4	9·6	7·5	9·4	12·2	13·5	15·6	10·2	10·1	2·0	19·5	49·5	6·5	6·0
873	,,	4·2	4·4	9·6	8·5	10·4	9·9	9·6	13·7	8·1	9·0	1·8	20·2	51·3	7·0	6·5
910	,,	5·5	8·2	11·8	10·1	13·4	15·6	12·3	22·3	9·2	12·4	2.4	21·5	54·6	8·0	5.5
928	,,	3·6	3·7	9·9	6·9	8·2	8·4	8·9	15·4	8·0	8·4	1·6	21·0	53·3	6·0	5·0
1002	,,	3·6	4·4	8·4	7·7	10·7	13·7	10·1	19·7	11·0	10·6	2·0	21·5	54·6	7·0	6·0
1064	,,	4·1	3·4	7·4	5·2	7·7	9·9	7·3	21·7	9·5	9·1	1·8	20·0	50·8	7·0	6·0
1168	,,	3·0	3·1	8·7	4·9	7·1	7·6	6·6	12·2	10·0	7·4	1·4	19·0	48·3	7·0	5·0
1205	,,	3·5	2·2	6·3	6·4	7·7	12·8	10·8	15·4	9·2	8·9	1·7	20·7	52·6	7·0	5·0
1229	May 1929	2·3	1·6	5·0	6·6	8·1	8·0	8·1	15·2	8·5	7·8	1·5	18·7	47·5	7·0	5·5
1321	,,	4·4	3·5	10·8	5·4	4·6	8·2	6·4	15·4	11·0	8·1	1·5	20·7	52·6	8·0	5·0
Aveage for clone		3·8	4·1	8·7	7·2	8·9	11·0	9·4	16·6	9·3	9·2	1·8	20·3	51·5	6·9	5·5

Tapping System. Half spiral on alternate days.

TABLE IV.

CLONE HILLCROFT 28. 1933.

Tree No.	When budded	Average yield in grams dry rubber per tapping.													Total yield for year 1933	Average dry rubber content.	Girth at 3 ft in July 1933		Thickness of bark	
		1932	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1933					Primary in Feb. 1934.	Renewing at 3 ft. 22 months' renewal.
		Number of tappings																		
		55	12		12	7	8	10	8	11	6	12	14	100	lbs.	%	ins.	cms.	mms.	mms.
1	Sept. 1926	52·4	68·9		56·7	48·0	43·9	61·7	56·2	62·7	60·9	71·2	59·4	60·0	13·2	40·0	31·7	80·5	10·5	7·0
2	,,	45·9	51·5		50·4	45·3	44·2	56·2	57·0	57·0	56·6	73·0	49·8	54·4	12·0	39·3	28·0	71·1	8·0	7·5
3	,,	45·7	48·0		56·2	39·5	29·9	38·9	44·4	47·9	52·4	53·0	48·2	46·4	10·2	39·9	29·2	74·2	9·0	7·5
4	,,	35·5	39·3		35·2	30·0	30·1	40·8	37·4	34·8	46·4	50·1	35·6	38·1	8·4	38·4	27·2	68·1	8·5	6·5
5	,,	38·2	39·8		47·7	35·6	33·1	45·7	43·7	44·0	60·5	56·8	43·9	45·1	9·9	38·1	25·9	65·8	8·5	6·5
6	,,	35·9	38·7		46·2	36·5	33·3	43·0	25·8	40·9	54·5	59·6	45·2	43·0	9·5	40·8	27·9	70·9	8·0	7·0
7	,,	43·8	52·5		51·8	43·7	37·7	55·0	44·9	35·5	56·4	72·4	51·9	50·9	11·2	40·7	30·5	77·5	7·5	7·5
8	,,	49·7	52·7		49·2	41·2	39·0	61·0	37·6	44·8	58·4	64·9	47·2	50·2	11·0	38·2	27·4	69·6	8·5	6·5
9	,,	33·3	40·7		40·2	34·8	29·0	37·3	37·5	36·0	56·1	49·9	41·2	40·3	8·9	39·4	28·5	72·4	9·0	7·0
10	,,	33·9	39·3		36·0	29·9	26·8	41·3	36·5	42·7	52·6	58·6	48·5	42·0	9·2	43·2	27·5	69·8	8·0	8·0
11	,,	41·1	49·4		43·3	37·1	33·1	53·9	44·1	42·8	37·7	53·7	35·6	43·7	9·6	37·2	28·6	72·6	8·5	8·0
12	,,	42·4	49·0		50·0	45·4	31·0	44·1	44·7	45·0	49·3	53·4	44·0	46·1	10·1	40·8	30·0	76·2	8·5	8·0
Average for clone		41·9	47·5		46·9	38·6	34·3	48·3	42·5	44·6	53·5	59·8	45·9	46·7	10·3	39·7	28·5	72·4	8·5	7·2

RESTED

Tapping System. Half spiral on alternate days.

TABLE V.

CLONE HILLCROFT 34. 1933.

Tree No.	When budded	Average yield in grams dry rubber per tapping													Total yield for year 1933	Average dry rubber content	Girth at 3 ft in July 1933		Thickness of bark	
		1932	Jan	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1933					Primary at 3 ft in Feb. 1934	Renewing 22 Months' renewal.
		Number of Tappings																		
		54	12		12	7	8	9	8	11	7	11	14	99	lb.	%	ins.	cms.	mms.	mms.
1	Sept. 1926	28·0	33·1		35·2	27·7	21·0	30·7	22·2	20·5	25·8	33·9	29·9	28·6	6·2	41·9	22·2	56·4	7·5	7·5
2	,,	20·7	19·5		17·0	15·8	12·0	15·9	18·1	13·5	21·3	22·7	16·3	17·1	3·7	38·3	19·0	48·3	6·5	4·5
3	,,	41·1	41·6	RESTED	39·6	28·1	23·4	31·7	30·0	26·8	37·7	40·3	31·0	33·5	7·3	42·4	22·0	55·9	7·5	6·5
4	,,	30·3	30·7		29·6	21·5	20·2	28·1	22·7	20·6	43.2	44·6	30·1	29·4	6·4	38·3	19·0	48·3	6·5	6·0
5	,,	28·1	27·5		29·7	24·2	17·5	27·2	27·8	17·2	28·2	32·2	34·3	27·1	5·9	47·6	21·7	55·1	7·5	6·5
6	,,	33·1	34·8		41·2	26·1	23·7	43·1	31·5	25·1	33·6	39·5	27·1	32·8	7·2	41·7	21·5	54·6	7·0	7·0
7	,,	32·7	36·9		36·0	23·8	18·7	27·4	25·1	26·0	33·2	34·1	32·0	30·1	6·6	42·8	21·7	55·1	7·5	7·5
Average for clone		31·4	32·0		32·6	24·1	19·5	29·1	25·3	21·4	31·9	35·3	28·6	28·3	6·2	41·9	21·0	53·3	7·1	6·5

Tapping System. Half spiral on alternate days.

TABLE VI

CLONE HILLCROFT 55, 1933.

Tree No.	When planted	Average yield in grams dry rubber per tapping											Total yield for year 1933 and No. of tappings		Average dry rubber content	Girth at 3 ft. in July 1933		Thickness of bark	
		Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1933						Primary at 3 ft. in Feb. 1934	Renewing 8 months' renewal
		Number of tappings																	
		7	11	7	8	10	8	11	7	12	14	58-95	lb.	tappings	%	ins.	cms.	mms.	mms.
1	1926	52·6	52·9	33·1	38·2	39·9	56·4	50·3	56·6	52·5	40·1	47·2	9·9	95	30·4	30·7	78·0	8·0	6·0
2	,,	48·9	47·1	44·0	51·2	71·5	66·3	70·4	74·2	80·9	62·7	62·8	13·1	95	35·6	32·5	82·6	6·0	6·0
3	,,		150·7	81·4	94·3	96·0	93·7	91·2	105·8	110·5	78·8	98·3	18·2	84	36·3	27·4	69·6	9·0	6·0
4	,,				52·0	57·3	50·1	51·5	62·4	63·9	51·4	55·6	8·3	68	29·0	32·4	82·3	7·0	6·0
5	,,				38·3	41·1	35·4	41·9	49·1	46·8	37·8	41·4	6·2	68	32·3	28·1	71·4	7·0	5·0
6	,,				27·3	25·3	24·8	22·9	27·4	36·1	22·3	26·5	4·0	69	34·6	27·4	69·6	7·0	4·0
7	,,				12·0	12·2	12·7	12·8	17·8	16·5	13·4	13·9	2·1	69	35·4	24·5	62·2	8·0	4·5
8	,,				12·5	18·6	19·9	20·3	28·0	26·0	13·8	19·7	2·9	67	32·0	26·7	67·8	6·0	3·5
9	,,				40·0	48·8	35·3	42·5	51·6	60·1	53·6	48·4	7·5	70	37·1	27·0	68·6	6·5	4·5
10	,,				57·3	58·2	40·4	78·2	69·0	74·2	*31·8	63·1	8·1	58	33·3	31·4	79·8	8·0	6·5
Average for clone		50·7	74·3	52·8	43·5	46·9	43·3	48·5	54·6	56·9	41·4	49·1	8·0	74	32·7	28·8	73·2	7·25	5·2

Tapping System. Half spiral on alternate days.

* Developed Brown Bast in December

TABLE VII

MILLENIYA AND WAWULUGALA CLONES 1933.

Clone	When budded	No. of trees	Average yield in grams dry rubber per tapping												Average total per tree for year 1933	Average girth at 3 ft. in May, 1933		Thickness of bark	
			1932	Jan.	Feb.	Mar.	April	May	June-Aug.	Sept.	Oct.	Nov.	Dec.	1933				Primary at 3 ft. in March, 1934	Renewing 26 months' renewal
			No. of tappings																
			22	8	7	7	7	7		8	6	14	14	78	lb.	ins.	cms.	mms.	mms.
M. 191	Aug. Oct., 1927	10	39·2	25 3	23·1	10·1	34·1	48·8	RESTED	32·6	30·9	38·5	42·6	31·8	5·4	28·7	72·9	7·8	6·7
W. 120	August 1927	10	24·7	23·2	23·7	17·1	29·4	29·4		22·3	19·9	23·2	29·3	24·3	4·2	23·4	59·4	7·3	6·2
W. 259	May-Sept. 1927	10	33·5	34·6	33·2	25·8	52·3	44·6		32·9	41·7	44·5	47·9	40·8	7·0	25·1	63·8	8·3	7·4
W. 320	Aug-Sept, 1927	10	33·7	30·2	31·4	23·0	42·3	33·4		27·2	28·9	31·7	37·1	32·1	5·5	21·2	53·8	7·2	6·0

Tapping System. 1932 and January-May, 1933. "Double-Three" i. e., two opposite half spirals every 3 days.

September-December, 1933. Alternate day on alternating opposite half spirals i. e , each cut singly every 4 days.

DISEASES OF RUBBER IN CEYLON, 1933

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1. FOREWORD

NO outstanding developments as regards Rubber diseases are to be reported for 1933. It is nevertheless considered desirable to maintain the continuity of this series of brief annual reviews.

2. ROOT AND COLLAR DISEASES

In the wet districts *Fomes lignosus* root disease continues to be the most serious source of loss, and there is no doubt that many estates which have neglected control measures during the years of depression are building up a load of trouble for the future. The necessity for keeping the spread of this fungus under control cannot be too urgently stressed. Not only does effective treatment become very costly and often impracticable where large areas are involved, but such land is likely to be useless in the event of replanting operations being contemplated.

Attack by *Ustulina zonata* on root, collar and stem is also important in wet districts. Since this fungus is only a wound parasite its control is dependent on adequate measures of estate sanitation, and in this respect it must be placed in a different category to *Fomes lignosus* and other true root parasites. Detection of fructifications in the early stages is the first necessity in the control of collar and stem infection, and this can only be done by periodical inspection.

3. STEM DISEASES

Despite the protracted monsoonal rains the diseases caused by *Phytophthora palmivora* have not been unduly severe. The measures adopted to prevent bark rot are adequate on most well managed estates, and the position as regards canker and secondary leaf-fall gives rise to no apprehension.

The brighter market prospects have revived interest in the treatment of Brown Bast, and the scraping and isolation treatment recommended by the Research Scheme has been undertaken on a few estates.

4. LEAF DISEASES

As stated above defoliation due to *Phytophthora* was not abnormally severe on most estates, although the rains associated with the S. W. Monsoon continued until October.

The position as regards *Oidium* leaf disease cannot, unfortunately, be regarded with such equanimity. There has been a considerable extension of the most severely affected areas at mid-country elevations, notably in the Matale district. For some years the disease has been extremely destructive at the higher elevations in this district, but in 1933 many estates in the Matale valley, which had previously experienced only the mildest form of attack, suffered somewhat severe defoliation, while the period during which the fungus was active was considerably extended. This marked increase in severity in a zone in which the climatic conditions were thought to be unsuited to the most intense form of attack appears to indicate acclimatisation of the fungus, and if the same tendency were to be evidenced in the main low-country districts the disease would have to be regarded with the utmost apprehension. The position is being carefully watched, and experiments on control by means of sulphur dusting continued. The effectiveness of the treatment under normally favourable weather conditions has been definitely established, and there is little doubt that operations can be successfully undertaken on a large scale. Further experience is necessary to determine under what circumstances the treatment is economic, but it is undoubtedly the only means by which severe defoliation can be prevented in the worst areas.

5. DISEASES IN BUDDED CLEARINGS

Injury to the callus bark growing over the stock snag of young buddings has been much in evidence after spells of hot dry weather during the last two years. The damage is attributed to sun scorch and is probably accentuated by any black filling mixture or dressing of the snag. Apart from the consequent delay to the healing of the union, the condition is dangerous in that it may afford a starting point for the attack of *Diplodia* and other wound parasites. It has only been observed where the stocks were large, and it is clear that where the healing of the union is a prolonged process the callus will be exposed to this form of injury during any long spell of hot dry weather. The best remedy is the provision of a natural shade by planting a screen of green manure plants so that the union is shaded from

the mid-day and afternoon sun. These may have to be tied to the stem so as to provide an effective shade, or loppings can be heaped over the union.

Fewer reports have been received of *Phytophthora* attack on young bud-shoots, though this may be due to a better acquaintance with the symptoms and control methods. As mentioned in previous years Clone B.D. 5 is particularly susceptible to this form of attack, though field experience varies widely on different estates even in the same district. Provided the clearing to be planted is of sufficient extent to ensure that the majority of the young budgrafts are not very close to an existing stand of mature Rubber, this clone may, it is considered, be planted without undue risk. In view of the possible susceptibility of the mature budgrafts to secondary leaf-fall, however, it is considered inadvisable in wet districts to plant a large area with this clone alone. It is not inconceivable that material of Clone B.D.5 which has been multiplied many times from the original importations may have acquired a greater degree of resistance to this disease, and that the stigma attached to this clone (which is otherwise desirable from all points of view) may in the future be removed.

FURTHER NOTES ON THE AFTER-TREATMENT OF BUDDED RUBBER STOCKS

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INTRODUCTION

IN the Rubber Research Scheme Combined *Third and Fourth Quarterly Circulars* for 1932 an interim report on an experiment undertaken at the Experiment Station, Nivitigalakele, to investigate the above subject was published. The observations reported then were made at a stage six months subsequent to the laying down of the experiment, and it is the intention of the present notes to record the results of an examination made some 7-8 months later.

It might be recalled that the experiment was undertaken to ascertain:

(1) the most effective method of treating budded rubber stocks whose cut surfaces had started to decay before the union had had time to callus over completely;

(2) the most effective method of treatment of budded rubber stocks at the time of cutting back, in order to prevent decay occurring.

In part 1 of the experiment, 12 plants were allotted to each of 6 treatments (including 2 controls) and each treatment was distributed in 3 different clearings on the Experiment Station. In Part 2, 24 plants were assigned to each of 7 treatments (including 1 control) all but two of which were distributed in two separate fields of the 1928 clearing. The treatments in Part 2 were renewed once in 6 months on half the plants under each treatment, the remaining half being left unrenewed for comparison. The treatments were:—

Part I. A. 12 plants untreated with cut-surface of stock healthy. Control.

B. 12 plants untreated with cut-surface of stock soft and decayed. Control.

C. 12 plants with the soft and decayed cut-surface of stock scooped out down to clean wood, disinfected with a 10 per cent. solution of Brunolinum plantarium and painted with Skene's pruning mixture.

D 12 plants with the soft and decayed cut-surface of stock scooped out down to clean wood, disinfected with a 10 per cent. solution of Brunolinum plantarium and painted with Colas.

E. 12 plants with the soft and decayed cut-surface of stock scooped out down to clean wood, disinfected with a 10 per cent. solution of Brunolinum plantarium, painted with Skene's pruning mixture, and filled with cement (1 cement to 2 sand) and shaded.

F. 12 plants with the soft and decayed cut-surface of stock scooped out down to clean wood, disinfected with a 10 per cent. solution of Brunolinum plantarium, painted with Colas and filled with a mixture of Colas and sand (1:2).

Part II. A. 24 plants with snags uncut. Control.

B. 24 plants with snags cut and Skene's pruning mixture applied over cut-surface.

C. 24 plants with snags cut, disinfected with a 10 per cent. solution of Brunolinum plantarium and Skene's mixture applied over cut-surface.

D. 24 plants with snags cut, and treated with a mixture of "Entwas" wax and 5 per cent. by weight of powdered sulphur.

E. 24 plants with snags cut, disinfected with a 10 per cent. solution of Brunolium plantarium and treated with a mixture of "Entwas" wax and 5 per cent. by weight of powdered sulphur.

F. 24 plants with snags cut, and treated with a mixture of Mexphalte and Kerosene (1:1).

G. 24 plants with snags cut, disinfected with a 10 per cent. solution of Brunolium plantarium and treated with a mixture of Mexphalte and Kerosene (1:1).

OBSERVATIONS

Part 1.—In regard to the treatment of cut-surfaces which had already started to decay the recent inspection showed that the recommendations made in the previous report needed but little modification. Where decay was merely superficial, the surfaces cleaned out down to healthy tissue, disinfected with a 10 per cent. solution of Brunolinum plantarium and treated with Skene's pruning mixture, as well as those treated with Colas, were well preserved and free from further infection, 5 out of 12 and 6 out of 12 stocks respectively under each of these treatments having completely callused over. Although the surfaces treated were satisfactorily maintained even at the end of one year from application, renewal every 6 months is to be recommended where complete callusing over is delayed. Where decay of the stock was of a less superficial nature and cleaning out left a hollow in which water could collect, the fillings, after disinfecting, of a plastic mixture of Colas and sand (1:2), as well the fillings of cement and sand (1:2), have proved suitable, over 75 per cent. of the number treated having callused healthily. The anticipated retarding of callus-formation due to possible resistance offered by the hard cement mixture was not in evidence, callusing being quite as rapid as in the specimens filled with the more plastic Colas and sand. It has however to be pointed out that such retarding is likely to occur if sufficient care is not taken to fill the cement to the level of the cut-surface only and not right up to that of the in-growing callus.

A disadvantage of the Colas-sand mixture under certain circumstances ought here to be mentioned. During the hot weather of February-March 1933 certain 2-4 year old budded plants in the field whose stocks had been previously filled with the Colas-sand mixture manifested a cracking and discolouring of the newly-formed cortical tissue round about the mouth of the filling, often resulting in secondary infection by *Diplodia* sp. which penetrated right down to the wood. In the opinion of the Mycologist, (*vide* "A Note on Sun-Scorch of Budgrafts" by R. K. S. Murray, R. R. S. *Second Quarterly Circular* 1933, p. 35), although this damage was primarily caused by sun-scorch, it appeared to have been accentuated by the heat absorbed by the Colas-sand mixture in hot weather. Mixtures with coir-dust or saw-dust as substitutes for sand are now being used at Nivitigala-kele with more promising results.

The two control groups which, at the previous inspection had not had time to show developments were re-examined.

Those plants whose cut-surfaces were soft and tindery but left untreated to ascertain whether decay would spread further with time, showed no case of decay spreading into the living tissues of the stock or scion, but did show an extension of the rot deeper into the dead wood which was present owing to the cuts originally having been made too flat. This fact clearly stresses the importance of cutting the stock, at the final de-snagging, right down to the level of the live wood, which is usually plainly demarcated as the snag withers and is due for removal. To do so, the optimum slope of the cut has been found to be approximately 45° from the horizontal (see figure 1). A flatter slope, which is a very common tendency, almost invariably results in a portion of the top of the cut stock dying back (see Figure 2). The dead wood so formed tends eventually to absorb water and start wood-rot, which in turn might infect the live tissues of the stock and scion. Especially is this likely to be the case where the plant, owing to poor soil conditions or other reasons, is not growing vigorously and where callus formation is slow. The danger also tends to increase according to the size of the stock, the cut-surface of a larger stock taking a longer time to callus over than that of a smaller. Those plants whose cut-surfaces were healthy but left untreated to ascertain whether they would, in time, develop infection were on the whole well-preserved, but this may be attributable to the fact that the surfaces were not strictly untreated, in that they had been painted with tar several months before the initiation of the experiment and were only utilised for it in the absence of entirely untreated specimens. A few cases however had begun to get soft down to about $\frac{1}{4}$ in. In both control groups approximately 50 per cent. of the specimens had callused over completely, showing that, provided the plant is vigorous enough to produce active callus growth, it is usually capable of encompassing the decaying cut-surface before any serious damage can occur.

Part 2.—The control group under this section of the experiment, which is to investigate the most suitable treatment and measures for avoiding the commencement of decay, consists of budded plants whose 6-8 inches long snags (see Figure 3), after the initial cutting down of stock, were left uncut to decay and fall over. From these controls it was intended to ascertain how far the practice of leaving snags to decay and fall over was commendable or not in relation to the present investigation. The group, on inspection, revealed that the snags of two-thirds of the plants had withered sufficiently to enable them to be knocked over with

slight pressure. The surfaces left by the fallen snags (see Figure 4) were in every case unevenly pitted and soft to a depth of $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. according to the quantity of decayed wood invariably left attached to the stock in knocking the snag over. Callus formation had commenced but had been prevented from closing in owing to the obstructing snag (see Figure 3) which had hitherto (*i.e.*, over an year since it was due for cutting) stood attached to the stock. The removal of the snag also generally left a cup-shaped hollow (see Fig. 4) in which water could lodge and start decay. The snags themselves were thoroughly rotted and riddled with white-ants, borers and numerous saprophytic fungi and so long as they remained attached to the plant could be a source of danger. In one case the fungus *Diplodia* sp. had infected the scion to a height of $1\frac{1}{2}$ inches from the union. The observations clearly suggest that the practice of leaving the snag to decay and fall over is undesirable, growth of the callus is retarded, and there is an increased danger of infection by harmful fungi.

The groups of stocks freshly cut, disinfected with 10 per cent. Brunolinum plantarium and treated with different mixtures to prevent subsequent infection and decay, provide evidence that, in so far as the protection of the cut-surfaces is concerned, the Skene's mixture has maintained its early promise and preserved the surfaces in a water-proof and disease-free condition even after one year from date of application. The group treated with the mixture of "Entwas" wax and 5 per cent. by weight of powdered sulphur has had most of the mixture melted away, which fact, together with other drawbacks mentioned in the previous report, confirms its general unsuitablity. The stocks treated with a mixture of Mexphalte ond Kerosene (1:1) were in satisfactory condition, but this mixture is possibly not to be recommended in the light of past experience in the field.

In all three groups a disappointing feature was observed. A number of the cut-surfaces which at the previous examination (*i.e.*, 6 months after application of the mixtures) had started to callus over quite promisingly—the callus having grown over the circular edge to as much as $\frac{1}{2}$ an inch in some cases—was found at the present inspection (12 to 14 months after application), with the original callus completely dead and a secondary callus commencing to grow over it (see Fig. 5). The nett result was that, from the viewpoint of callusing over of the cut-surface, these stocks, instead of advancing, had retrogressed since their

last inspection. How far this dieback of callus can be attributed to the mixtures used and how far to other causes cannot, at the present moment, be precisely determined but present observations point to the sun as the main cause. It is possible however that the effect of the sun is increased by the presence of a black protective coating. In the case of the entwas mixture, it has previously been reported from Malaya that dying back of the callus may result if exposure to sun causes the wax to melt. It should be mentioned that the first examination of the stocks when the primary callus was alive and growing was made in December 1932, *before* the February 1933 drought, and the second inspection when the callus was dead in July 1933, *after* the hot weather, thereby suggesting influence from the sun. Further investigations on this point will be carried out.

No noticeable difference was observed in any of the 3 groups, between the specimens disinfected with Brunolinum plantarium and those not so disinfected, although this does not detract from the value of disinfecting as a desirable prophylactic measure. Nor was any material difference in effect evident between the specimens in each group which had the mixture renewed every six months and those which had not, except that in the former case a thicker surface covering was maintained. However, renewal every six months, especially under extreme climatic conditions, is preferable, care being taken to confine the mixture on subsequent applications to the exposed cut-surface only and not to cover the growing callus.

A point to which attention was drawn was the effect which the difference in vigour between the budded-plants of the two fields in which the treatments were replicated seemed to have on their powers of disease resistance. The one field, though budded earlier, contains a poorer and less vigorously-growing stand of trees (due to inferior soil conditions) than the other, and during the present investigation it was interesting to note that the callus-formation in this field was generally less rapid, and the tendency for the cut-surfaces to decay relatively greater, than in the other. The need, therefore, to stimulate active growth of buddings culturally has to be stressed as one of the means of ensuring disease-free unions.

In considering the observations made in this report it should be remembered that they refer mainly to buddings on comparatively large stocks. It is unlikely that serious difficulties will arise in connection with the callusing of vigorous stocks budded at the normal age of 18 months to 2 years.

CONCLUSION

Although in an investigation of this nature considerable time must elapse before a final summing-up can be attempted, which even then must always remain open to modification in the light of later research, up to the present stage and within the scope of this investigation a number of recommendations suggest themselves which may be briefly summarised as follows:—

Preventively:—

(1) Avoid leaving the stock "snag" uncut to decay and fall off.

(2) When finally de-snagging cut right down to the level of live wood, maintaining a slope of 45° from the horizontal (see Figure 1) in order not to leave a piece of dead snag attached to the stock.

(3) Immediately disinfect the cut with a 10 per cent. solution in water of Brunolinum plantarium and paint over next day with Skene's pruning mixture or other waterproof covering. Repeat the treatment every six months so long as the cut-surface has not completely callused over, but avoid applying the mixture on the growing callus.

(4) Ensure vigorous growth of budded-plants in the field by cultural measures.

Curatively:—

(1) Where the decayed cut-surface of the budded stock leaves no hollow on cleaning out with a knife or chisel, disinfect with 10 per cent. Brunolinum plantarium and apply a suitable waterproof covering. Repeat treatment every six months until callusing is completed.

(2) Where a decayed cut-surface leaves a hollow on cleaning out, disinfect with 10 per cent. Brunolinum plantarium and plug with a mixture of Colas and coir-dust ($1\frac{1}{2}$:2), which at the present stage appears to be preferable to Colas and sand (1:1).

W. I. P.

Fig. I.

Budded stock cut to correct slope (*i.e.*, approximately 45° from the horizontal).

W. I. P.

Fig. II.

Portion of cut stock (above dark horizontal line) that has died back owing to cutting the stock too flat. The demarcations are natural.

W. I. P.

Fig. III.

Budded plant with stock "Snag" left to decay and fall over. Note decayed snag and its interference with callusing over.

W. I. P.

Fig. IV.

Budded joint with dead snag removed. Note portion of decayed and pitted wood left behind in cup-shaped hollow.

W. I. P.

Fig. V.

Budded stock showing original ring of callus round the cut-surface dead and a secondary callus growing over it.

NOTES ON CROSS-POLLINATION OF RUBBER *(HEVEA BRASILIENSIS)* IN CEYLON

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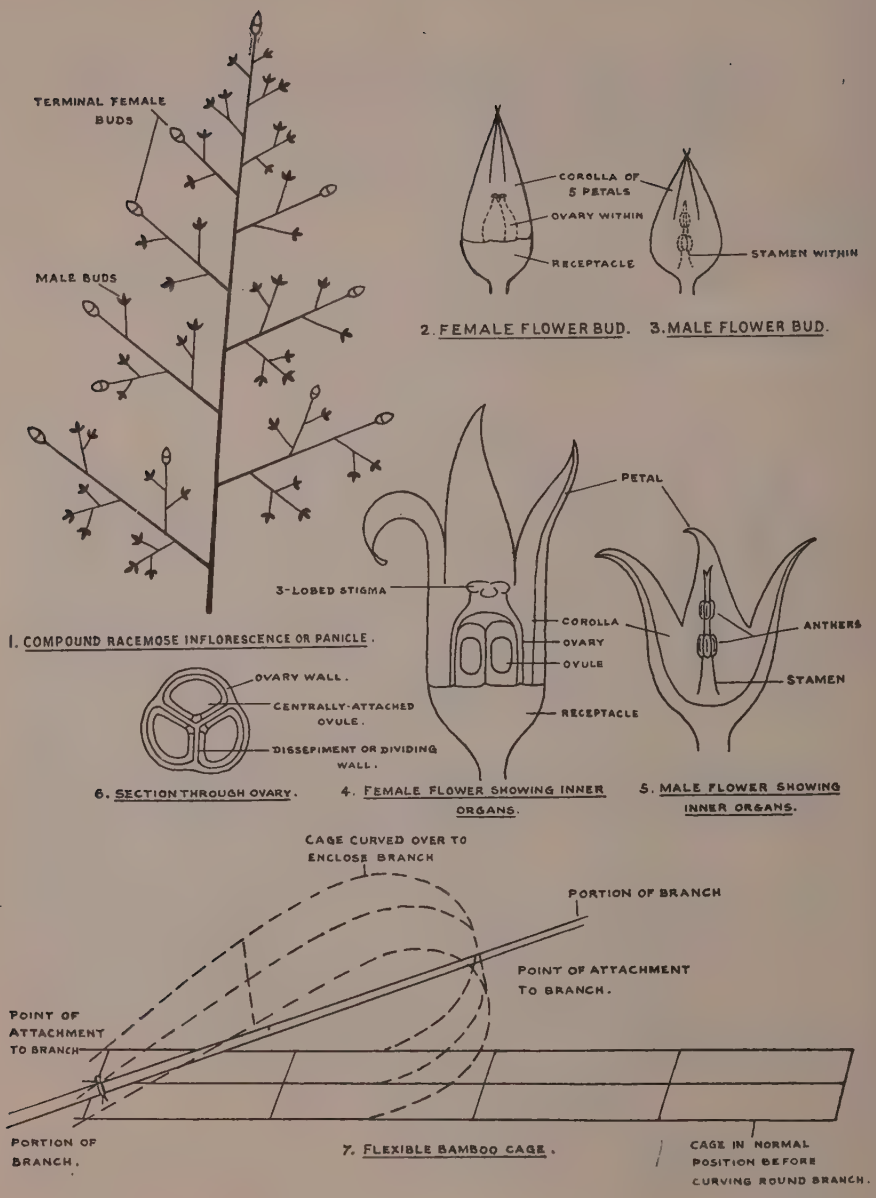
RUBBER RESEARCH SCHEME (CEYLON)

INTRODUCTION

AS there appears to have been little or no previous work done in Ceylon on the above subject it is hoped that the ensuing remarks based on work carried out by the writer at the Rubber Research Scheme Experiment Station, Nivitigalakele, during the past two years may be of interest. It will be known to those connected with the Rubber Plantation Industry that the yield of latex from individual trees varies very substantially. Extensive research has been carried out in Java, Sumatra and Malaya with a view to improving the yield of future plantations both by the asexual or vegetative method of budgrafting with material from selected high yielding trees and by the sexual method of cross-pollinating high yielding trees for the purpose of evolving improved seedling progeny. Work on the former lines has been undertaken in Ceylon at Nivitigalakele where budgrafts from a large number of local high yielding trees have been established but hitherto improvement by artificial cross-pollination of selected trees has not been attempted. The present notes refer mainly to cross-pollination of the flowers of budgrafts at Nivitigalakele which have reached an age at which flowering occurs.

MORPHOLOGY OF FLOWER

A preliminary need in embarking on work of this kind is to acquire a clear knowledge of the anatomy of the flower. The *Hevea brasiliensis*, being monœcious, has both its staminate (male) flowers and pistillate (female) flowers on the same tree (in fact on the same inflorescence—*vide* diagram I), and a close look soon reveals the external difference in form of the one from



W. I. P.

Structure of the Inflorescence and Flowers of *Hevea Brasiliensis*. At the bottom is shown the method of making a bamboo cage around the inflorescence.

the other. The female flowers are confined to the terminals of the main and stronger side axes of the inflorescence, which is a compound raceme or panicle, and are larger in size, fewer in number and of different formation to the male flowers. The former (diagram 2) in addition to the corolla of 5 yellow petals has a distinct light-green cup-shaped bottom half—receptacle—whereas the latter (diagram 3) is yellow throughout and has no green receptacle. Under the dissecting microscope the variation in structure is further marked. The "female" (diagram 4) consists of a syncarpous trilocular gynaecium (*i.e.* a 3-celled ovary) standing on the aforesaid light green receptacle and surrounded by the corolla of 5 yellow petals. The summit of the ovary tapers into a blunt three-lobed stigma. The male flower (diagram 5) which has no receptacle reveals, within its yellow corolla, a tiny white perpendicular monadelphous stamen (*i.e.* filaments of stamens united into one) carrying two whorls of 5 yellowish anthers each. Each anther contains 2 pollen sacs, which on dehiscing (generally shortly after the flower opens) sets free the sticky, dust-like, circular pollen grains inside it.

TECHNIQUE AND EQUIPMENT

The method of cross-fertilisation adopted was to take a male flower from the required source, divest it of its petals with as little movement as possible and, getting hold of the bottom of the stamen (see diagram 5) by means of a pair of pointed forceps, to rub that portion of it bearing the now-ruptured pollen sacs gently over the receptive stigma (see diagram 4) of the particular female flower required to be fertilised. The operation is somewhat delicate and care has to be taken not to injure the surface of the stigma by careless or excessive rubbing. Provided the operation has been carried out at the correct stage of development of the flowers, and allowing for other natural causes of failure, the pollen grains so transferred to the sticky surface of the stigma germinate and fertilise the centrally-attached ovules (later seeds) that are inside the ovary. Directly the ovules are fertilised the ovary (seed pod) begins to enlarge and for the first time the success of one's labours may be ascertained. The mature rubber pod belongs to the category of syncarpous dry dehiscent fruit known botanically as a "capsule".

Apart from the technique described above, in experimental work numerous precautionary and safety measures have to be adopted. All inflorescences whose female flowers are to be pollinated are enclosed in muslin or fine transparent cotton-cloth

bags before the flowers open. This is best done at a stage not too early to stifle the flowers and not too late to allow natural fertilisation from unknown sources to take place. In view of the fact that in Ceylon the first male flowers on an inflorescence open 7-10 days before the first "females", a safe stage for bagging is when the first "males" are swelling to open. Careful watch is kept thereafter until the "females" open, upon which they are fertilised with pollen from the particular source selected. To prevent the muslin bag, especially when wet, from sagging against the flowers a bamboo cage (diagram 7) made of flexible strips of split "bata" (*Ochlandra* sp.) is sometimes used. The experience gained at Nivitigalakele however is that except in special instances its use is somewhat superfluous, not to say troublesome, in that the leaf fronds around an inflorescence usually quite successfully perform the same function.

The actual transference of pollen is done with the aid of a pair of pointed forceps about 5 in. long, which also serves to remove the petals of the male flower from the single column-like stamen bearing the pollen. A tall step-ladder and, at times, scaffolding round particular trees, are necessary. Immediate labelling of each inflorescence pollinated is strictly observed so that no mistakes may arise subsequently regarding the crosses made. The label, preferably a non-corrosive metal one, should primarily bear the name (number) of the male parent with which the particular inflorescence was fertilised and, if more than one inflorescence has been done on the same tree, the number of the inflorescence. Accurate records of dates of bagging, pollinating and unbagging, number of flowers pollinated and number of successes obtained are kept for each inflorescence. This is not as tedious as it sounds if entered in tabular form in an exercise book. In experimental work, flowers on a single inflorescence are never fertilised with more than one variety of pollen and an inflorescence is never unbagged until all its female flowers are safely past the stage when they can be further fertilised. This can easily be determined when the stigmas turn dry and change to a dark or brown colour. If speedy unbagging should be necessitated for any special reason, all unopened "females" should first be plucked before removing the bag.

OBSERVATIONS

Results of rubber pollination in other countries show that an average success of over 15 per cent. has seldom been obtained and that a figure below 10 per cent. is far more general. Work done at Nivitigalakele mainly among young budded clones gave,

in 1932, 7 successes out of 103 (7 per cent.) and in 1933, 52 out of 822 (6·3 per cent.). It is however interesting to note that, among the pollinations carried out in 1933, whereas a successful percentage of 18 per cent. was obtained from crosses where both male and female parents were mature estate trees, and 9 per cent. where the female was a mature estate tree and the male a young budded tree, only 3 per cent. were successful where both parents were comparatively immature buddings flowering only for the first or second time. Similarly in 1932 mature estate tree crosses gave a success of 29 per cent. as against 2 per cent. from young buddings. Although these results may not be adequate to justify a definite conclusion in view of the fact that subsidiary factors have come into play, they tend to show that flowers of more mature trees incline to give a higher percentage of success than those of younger trees which have only flowered for a season or two; while the total average successes for the two years 1932 and 1933 support the view with limitations, that average successful percentages of over 15 per cent. are more the exception than the rule in work of this kind. The reason for the latter phenomenon has to be sought partly in nature where the rubber tree like most other prolific flowerers has to be controlled against over-production, and partly no doubt from defects in the technique adopted.

The outbreak of *Oidium Heveae* which often manifests itself on the inflorescences during the pollinating season is found, in Ceylon, to be a considerable handicap. Flowers so infected either drop wholesale or do not open, thus affecting both the scope for, and results of, pollination. The interference from this source has been sufficiently great to make it necessary to resolve to undertake sulphur-dusting of inflorescences prior to pollination in future years.

Although it seems reasonable to expect that bagging of inflorescences unduly early may retard or inhibit the proper development of the flowers and their subsequent opening, in actual practice it was found that inflorescences on which bags were put somewhat over-early, that is to say about 12 days before the first males started swelling to open, actually opened some days before ones left unbagged as controls on the same branch and of the same stage of maturity. Certain bags were left round inflorescences to ascertain whether natural self-fertilisation by wind would take place within the bag. In no case did this

occur, tending to show that self-fertilisation of rubber in so far that females of an inflorescence are naturally wind-pollinated by males on the same inflorescence occurs rarely, if at all, although successful self-fertilisation by artificial methods has been recorded by workers in other countries.

Dry weather during the "set" was found to be an important necessity. Wet conditions generally meant that the pollen transferred to the stigmas got washed away before it had time to fertilise the ovules or that the moist conditions persisting inside the bag caused the flowers to rot.

The choice of the parent trees, especially the female, appears to require more attention than one at first is inclined to imagine. Pollinations on certain trees, whether estate seedlings or clonal buddings, give no successes despite the most careful technique and favourable conditions while others set seed much more freely. In this respect it is observed that the robustness and general healthy appearance of the tree in relation to size, colour of leaf, tendency to fruit in previous years, size and appearance of flowers, absence of manifestation of disease, play a not unimportant part and that due observance of these factors may considerably increase the season's successes.

In addition to the aspects of rubber pollination dealt with above several important lines of investigation particularly in relation to the viability and mode of transference of rubber pollen, the actual agents causing natural fertilisation, possibilities of self-fertilisation, etc. remain to be explored. It is hoped to pay due regard to these in the near future when the scope for investigation at Nivitigalakele is larger than at present and when the buddings have reached a more advanced stage of maturity.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the twentieth meeting of the Board of Management, held at 11 a.m. on Thursday, March 15, 1934, in Room No. 213, New Secretariat, Colombo.

Present:—Dr. W. Youngman (in the chair), Messrs. C. H. Collins, C.C.S., (Representing the Financial Secretary), I. L. Cameron, A. E. de Silva, C. E. A. Dias, J.P., H. R. Freeman, M.S.C., F. H. Griffith, Col. T. G. Jayewardene, V.D., M.S.C., Messrs. J. L. Kotalawala, M.S.C., P. R. May, F. A. Obeyesekere, M.S.C., C. A. Pereira, B. M. Selwyn, E. C. Villiers, M.S.C., Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director of Research, was present by invitation and acted as Secretary.

Apology for absence was received from Mr. L. P. Gapp and Mr. B. F. de Silva.

MINUTES OF THE NINETEENTH MEETING OF THE BOARD

Draft minutes which had been circulated to members were confirmed and signed by the Chairman.

BOARD

The Chairman welcomed to the Board Mr. C. H. Collins who had been appointed to represent the Financial Secretary in place of Mr. C. W. Bickmore who was shortly leaving the island on retirement. He took the opportunity of expressing his personal indebtedness to Mr. Bickmore for his valuable assistance since the inception of the Board and thought that members would also wish to express their appreciation of his services. It was decided to record a vote of thanks to Mr. Bickmore for his services to the Board.

The Chairman also welcomed to the Board Mr. P. R. May who had been appointed to act from March 1st in place of Mr. E. W. Whitelaw who was shortly proceeding on leave. Mr. I. L. Cameron was also proceeding on leave but an acting appointment had not yet been made.

DECISIONS BY CIRCULATION OF PAPERS

Appointment of Assistant Chemist.—The Chairman reported that Mr. M. W. Philpott had accepted the appointment on the revised terms which Board members had approved by circulation of papers. It was expected that Mr. Philpott would arrive in Ceylon during April. Correspondence relating to the appointment was tabled.

ACCOUNTS

(a) *Expenditure in excess of estimates during 1933.*—The Chairman reported that covering sanction was required for over-expenditure of certain individual votes during 1933. Total expenditure for the year was substantially below the estimate. The votes were approved.

(b) *Balance Sheet and Income and Expenditure Account for 1933.*— The Chairman invited comments on the Auditor's report and accounts which had been circulated to members. After discussion, the accounts and Auditor-General's report were adopted.

(c) Fixed deposits made since last meeting were reported.

(d) Accounts of Nivitigalakelle and Dartonfield Estate for November and December, 1933 and January 1934 were tabled. It was reported that copies of the accounts were being circulated to the Estate Committee as from January, 1934.

(e) Statements of receipts and payments of the Board and of the London Advisory Committee for Rubber Research (Ceylon and Malaya) for the quarter ended December 31, 1933 were adopted without discussion.

ANNUAL REPORT FOR 1933

The Chairman invited comments on the report of the work of the Rubber Research Board in 1933, which had been circulated to members. After discussion and minor alterations of wording, the report was adopted. It was decided that the report should be published in the same way as last year.

DEVELOPMENT OF THE RESEARCH SCHEME

(a) Recommendations of the Estate Committee in regard to Buildings at Dartonfield.

1. FACTORY

After discussion it was decided to accept the specification and tender submitted by Messrs. Brown & Co., Ltd. for the construction and equipment of an experimental factory at Dartonfield Estate, subject to consideration by the Committee of various suggestions made during the discussion. A vote of Rs. 60,000 was approved to cover the cost of factory together with a further Rs. 25,000 for the purchase of vulcanizing and testing appliances.

2. OTHER BUILDINGS

It was decided to invite Messrs. Billimoria and De Silva to prepare plans of other buildings sanctioned in the estimates, for consideration by the Board at the next meeting. Consideration of the cost of the buildings was deferred until plans and estimates were available.

(b) Other recommendations of the Estate Committee.

1. CART ROAD

The vote for extension of cart road was increased from Rs. 3,000 to Rs. 4,000.

2. ESTATE SUPERINTENDENT

The Chairman reported the appointment of Mr. D. L. Nicol as Estate Superintendent as from January 15th, 1934. Approval was given for a bungalow to be rented at Pimbura Estate and a motor cycle allowance to be paid to Mr. Nicol until quarters are available at Dartonfield.

3. BULLOCK CART

A vote of Rs. 250 for the purchase of a pneumatic tyred bullock cart was approved.

4. RUBBER RESTRICTION

In the event of a rubber restriction scheme being introduced, the Chairman was authorized to apply to Government for Dartonfield to be exempted from restriction of crop.

5. MEMBERSHIP OF PLANTERS' ASSOCIATION, ETC.

After discussion it was decided to retain membership of the Planters' Association and the Ceylon Estates Proprietary Association in respect of Dartonfield Estate and to apply for membership of the Low-Country Products Association.

Consideration of other items on the agenda was postponed until next meeting.

PUBLICATIONS

Fourth Quarterly Circular for 1933 was tabled.

RUBBER RESEARCH SCHEME (CEYLON)

LIST OF PUBLICATIONS FOR SALE.

Bulletins Re. 1-20. Bound volume **Rs. 5-00. Later Bulletins Re. 1-00** per copy

No. 1. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 2. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 3. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis Part I.
No. 4. The Physiological Effects of Various Tapping Systems, Part I.
No. 5. Progress Report on Vulcanization Tests
No. 6. The Physiological Effects of Various Tapping Systems, Part II.
No. 7. Do Do Do Part III
No. 8. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis, Part II.
No. 9. Vulcanization Tests.
No. 10. Do.
No. 11. Variability in Rubber Manufacture.
No. 12. Progress Report of the Rubber Research Chemist.
No. 13. Vulcanization Tests.
No. 14. On the Variation in the Number of Latex Vessels present in Hevea brasiliensis.
No. 15. Vulcanization Tests.
No. 16. On the Natural Clotting of Rubber Latex.
No. 17. Vulcanization Tests.
No. 18. Measurements of "Bark Renewal."
No. 19. Vulcanization Tests.
No. 20. Do.
No. 21. Do.
No. 22. Do.
No. 23. Do.
No. 24. Do.
No. 25. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 26. Results of Trials of Ceylon Plantation Rubber for the manufacture of Ebonits.
No. 27. Investigations on Samples of Plantation-Para Rubber from Ceylon.
No. 28. Do.
No. 29. Summary of the Principal Results obtained from Investigations into the Properties of Ceylon Plantation Rubber in relation to its Method of Preparation.
No. 30. The penetration of disinfectant on the tapping cut of Hevea brasiliensis.
No. 31. On the Occurrence of "Rust" on Sheet Rubber.
No. 32. On the Preservation of Latex.
No. 33. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 34. Do.
No. 35. Do.
No. 36. Do.
No. 37. Do.
No. 38. Do.
No. 39. Do. (Final Report Series I.)
No. 40. Do Series II.
No. 41. Do. First Interim Report on artificial ageing tests.
No. 42. On the Smoking of Sheet Rubber in relation to Mould Prevention.
No. 43. The inter-relationship of Yield and the various Vegetative Characters in Hevea brasiliensis. (out of print).
No. 44. The Construction of Smokehouses for Small Rubber Estates. (out of date).
No. 45. The Efficiency of Disinfectants and Fungicides.
No. 46. The Control of Bark Rot by Disinfectants.
No. 47. Report on Variability of Ceylon Estate Grades.
No. 48. Brown Bast and its Treatment.
No. 49. Report on Causes of Variation in Plasticity.
No. 50. Crepe Rolling.
No. 51. The Curing of Sheet Rubber.
No. 52. The Preparation of Uniform Rubber.

Booklets at Rs. 2-50 per copy.

Guide to the Preparation of Plantation Rubber, by T. E. H. O'Brien, M.Sc., A.I.C., Chemist.

The Budding of Rubber, by R. A. Taylor, B.Sc., Physiological Botanist. (out of date).

Diseases of Rubber in Ceylon, by R. K. S. Murray, A.R.C.Sc., Mycologist.